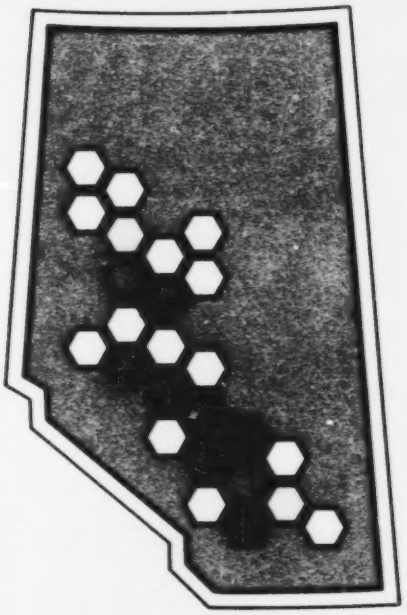
Information Series 101

Alberta Plains Coal Regions: Potential feedstock for coal conversion by liquefaction and pyrolysis

J.D. Campbell, M.P. du Plessis



Coal Research
Department

Alberta
RESEARCH COUNCIL
Energy Resources Division

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Alberta Research Council
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Copies of this report are available from:

Alberta Research Council
Editing & Publications Department
5th Floor, Terrace Plaza
4445 Calgary Trail South
Edmonton, Alberta
T6H 5R7
phone: 438-1666 ext. 221

Alberta Research Council
Industrial Development Department
Petroleum Recovery Institute
2nd Floor, 3512-33 St. NW
Calgary, Alberta
T2L 2A6
phone 282-9136

Introduction

Coal, believed to be suitable as feedstock for on-site conversion plants, is found in many very large deposits in the Alberta Plains; some of these deposits are difficult of access, others are already dedicated to thermoelectric power production, but many remain uncommitted. The Alberta Research Council presents the following report — an update and expansion of previous issues — as a guide to those coal deposits that are both suitable and available for conversion process.

It is believed that, under conditions foreseeable for the near future in Alberta,

1. the preferred feedstock for on-site coal conversion process should be subbituminous coal;
2. *liquefaction* (total transformation of coal to liquid hydrocarbon) and *pyrolysis* (stripping small amounts of valuable fluid hydrocarbon from coal, leaving a solid char residue available for combustion) will be the dominant conversion processes;
3. economic *liquefaction* process units would each produce more than 50,000 bbl/day for 30 years and would require dedicated coal reserves of about 250 x 10^6 tonnes (about 300 x 10^6 short tons);
4. *pyrolysis* processes will be mated to major thermoelectric power plants that are sited on dedicated coal reserves of 120 x 10^6 tonnes (about 140 x 10^6 short tons) or more.

Accordingly, the Alberta Research Council and Alberta Energy and Natural Resources direct the attention of interested parties to 15 "Coal Regions" in the Alberta Plains shown on the map (figure 1), summarized in table 1 and described in detail in the Appendix. All 15 of these "Regions" are easily accessible, possess already-developed social infrastructure and contain adequate reserves of subbituminous coal recoverable by current mining technology to support one or more process plants. None of them present insurmountable problems of use-conflict with agriculture, recreation or ecologically fragile environments.

Of the 15 "Coal Regions" thus delineated, 9 are believed to be suited to the liquefaction process industry; they contain adequate reserves and are not dedicated at present to power generation. These regions are numbers 1 through 9 in table 1. The remaining 6 "Regions," while not specifically excluded from liquefaction, are probably more suitable for power generation and in some cases are already dedicated to that use; these 6 are worth considering as sites for mated power/pyrolysis industry. These regions are numbered 10 through 15 in table 1.

The 15 "Regions" chosen for this report, while not coterminous with the administrative "Fields" of the Alberta Energy Resources Conservation Board (ERCB, 1982), are designated by reference to ERCB field names and consist of component sub-regions or "Deposits" that are identical to the "Deposits" of the ERCB. For instance, the Region "Mayerthorpe/Wabamun (part)" consists of 3 "Deposits" of the ERCB "Mayerthorpe" Field and 2 "Deposits" of the ERCB "Wabamun" Field.

Each "Deposit" referred to in this report has been assigned an arbitrary consecutive number, from 1 to 57, identified in the Appendix. These numbers are used for reference in the location map (figure 1), and in table 2.

The reserve tonnages reported below for each Region are those quoted by the Alberta Energy Resources Conservation Board for the respective "Deposits" (see ERCB, 1982).

Coal properties

Coal rank (ASTM) in the Alberta Plains ranges from high volatile C bituminous to Lignite A. Highest rank coals occur along the southwestern boundary of the Plains nearest the Rocky Mountain Foothills; decreasing ranks of coal are met at increasing distances eastward and northeastward. None of the Plains coals show caking properties.

All of the coal deposits noted in the Appendix (except the largely unsubstantiated Buffalo Hill Region) happen to be subbituminous B or subbituminous C in rank; these are the Plains coal deposits that are now economically accessible. Considerable tonnages of subbituminous A coals, however, lie in physically or economically inaccessible areas near the Rocky

Mountain Foothills, especially in northwestern Alberta. To facilitate small-scale study, the Alberta Research Council has collected one bulk sample representative of such coals from a collecting locality ("Smoky Tower") in Tp 63, R 2, W 6th Mer (54°26′ N; 118°16′ W), indicated in figure 1.

The analytical determinations reported in the Appendix for each Region were made in laboratories of the Alberta Research Council; proximate and elemental analyses are given, together with specific gravity and ash-fusion determinations when available. (See also Stansfield and Lang, 1944.)

Geologically, all "Deposits" referred to in this report are part of a single enormous wedge of coal-measures (with a few relatively thin marine bands included) that blankets the central and southern parts of Alberta. Although the "Deposits" occur at three distinct horizons within the wedge, they are so closely spaced in age (latest Cretaceous to earliest Paleocene) that they may be considered almost synchronous. The three horizons are: Oldman Formation (Early Late Cretaceous age); Horseshoe Canyon Formation (Late Cretaceous age); Scollard Member of Paskapoo Formation (Latest Cretaceous or Cretaceous-Paleocene boundary age).

Two major experimental and scale-up programs are under way to test Plains coals for their behavior in liquefaction and pyrolysis processes, but results are not yet suitable for publication.

In the last few years, substantial attention has been paid to the petrography of Alberta Plains coals in the laboratories of both the Institute of Sedimentary and Petroleum Geology, Calgary, and the Alberta Research Council, Edmonton. Considerable progress has already been made towards correlating petrographic analysis with performance of the coals in conversion processes (Parkash *et al.*, 1982). Table 2 presents petrographic analyses from Parkash *et al.* of 10 Alberta Plains coal samples that will serve for the present to demonstrate the range of petrographic variability. It should be noted that, in keeping with their immature rank, these coals contain considerable amounts of imperfectly formed vitrinite retaining much of the original woody (coniferous: *Taxodiaceous*) structure.

References

Energy Resources Conservation Board, Alberta (1982): Reserves of Coal, Province of Alberta, at 31 December, 1981; Report ERCB 82-31.

Parkash, S., M. Holuszko, C. Stangl, M.P. du Plessis, and A.R. Cameron (1982): Application of Coal Petrography in the Liquefaction of Subbituminous Coals and Lignites; Coal Research Department Report No. YCLQL-16, Edmonton: Alberta Research Council.

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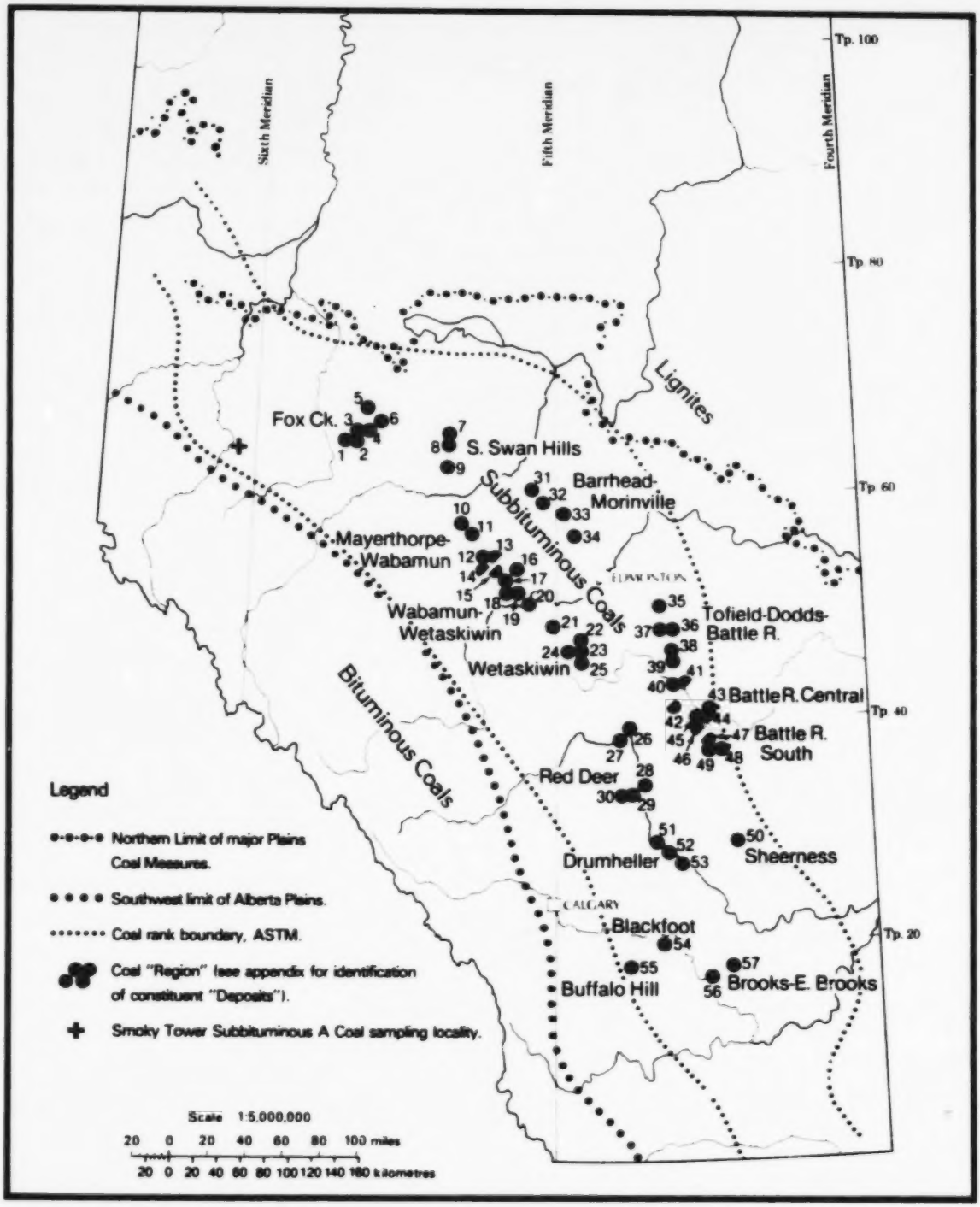

Figure 1. Alberta Plains coals for conversion process

Table 1. Alberta Plains coal regions with reserves suitable for coal liquefaction or for power/pyrolysis

	Region	Deposits	Remaining Reserves Tonnes x 10^9 Strip	Underground	Rank (ASTM)	Geology
1.	Fox Creek (part)	Giroux; Atikkamek; Meekwap W.; Meekwap E.; S. Brush Mt.; Goose R.	755	47	Sub. B	Scollard
2.	S. Swan Hills (part)	Freeman Ck; Judy Ck; Carson Lk.	295	95	Sub. C	Scollard
3.	Mayerthorpe/ Wabamun (part)	Rochfort Bridge; Jalna; Evansburg; Stanger; Magnolia	155	605	Sub. B	Scollard
4.	Wabamun/ Wetaskiwin (part)	Gainford; Whitewood; Sundance; Highvale-Low Water; Keephills; Genesee	1060	376	Sub. B	Scollard
5.	Wetaskiwin (part)	Thorsby; Wizard Lk; Patience; Falun; Bearhills	404	329	Sub. B	Scollard
6.	Red Deer (part)	Tees, Heatburg, Haynes; N. Ardley; Goosequill, Rumsey, Elnora; S. Ardley; Trochu	644	340	Sub. B	Scollard
7.	Barrhead/ Morinville (part)	Bloomsbury; Manola; Picardville, George Lk.; Manawan Lk.	525	33	Sub. C	Horseshoe Canyon
8.	Tofield-Dodds/ Battle River (part)	Tofield, Miquelon; Dusty Lk.; Dinant; Ohaton; Driedmeat Lk.; Meeting Ck.; Heisler	787	935	Sub. C	Horseshoe Canyon
9.	Battle River (central part)	Donalda, Forestburg; Central Battle R.; Paintearth; Gasby	240	36	Sub. C	Horseshoe Canyon
10.	Battle River (South part)	Halkirk; Castor; Sullivan Lk.	314	110	Sub. C	Horseshoe Canyon
11.	Sheerness	Sheerness	140	0	Sub. C	Horseshoe Canyon

Table 1. (continued)

	Region	Deposits	Remaining Reserves Tonnes x 10^6 Strip	Underground	Rank (ASTM)	Geology
12.	Drumheller (part)	Munson, Kneehill; Rosedale, Eladesor; E. Coulee, Western Monarch	3	461	Sub. B	Horseshoe Canyon
13.	Blackfoot	Blackfoot	100	22	Sub.B	Horseshoe Canyon
14.	Buffalo Hill	Buffalo Hill	0	440	Sub. A	Horseshoe Canyon
15.	Brooks/ E. Brooks (part)	Bow City - Kitsim; E. Brooks	140	40	Sub. B	Oldman

Table 2. Petrographic analyses of selected Alberta Plains coals (from Parkash *et al.*, 1982)

Sample No. (Parkash *et al.*)	Location	Deposit No. (this report)	Rank ASTM	Volume percent maceral composition (mineral-matter-free)					Vitrinite Reflectance (Random) %
				Vitrinite (Humi-nite)	Liptinite	Semi-fusinite	Fusinite	Other Inerti-nites	
1	Smoky Tower	-	Sub A	70.0	6.4	8.6	4.3	10.7	0.51 ± 0.05
2	Egg Lake	34	Sub C	85.0	4.0	7.0	1.0	3.0	0.40 ± 0.04
3	Starkey	(near 34)	Sub C	91.5	5.8	1.5	0.6	0.6	0.33 ± 0.03
4	Wabamun	16	Sub B	65.0	6.0	15.0	3.0	11.0	0.38 ± 0.02
5	Highvale	18	Sub B	74.6	2.1	22.2	1.1	nil	0.48 ± 0.04
6	Forestburg	43	Sub C	92.5	3.8	0.6	1.9	1.2	0.39 ± 0.04

Table 2. (continued)

Sample No. (Parkash *et al.*)	Location	Deposit No. (this report)	Rank ASTM	Volume percent maceral composition (mineral-matter-free)					Vitrinite Reflectance (Random) %
				Vitrinite (Humi-nite)	Liptinite	Semi-fusinite	Fusinite	Other Inerti-nites	
7	Vesta	44	Sub C	73.3	0.3	8.9	3.3	14.1	0.43 ± 0.04
8	Heatburg	26	Sub B	74.8	1.0	9.6	2.1	12.5	0.44 ± 0.04
9	Sheerness	50	Sub C	92.1	4.7	1.5	0.9	0.8	0.38 ± 0.03
10	East Coulee	53	Sub B	91.9	4.9	0.6	1.4	1.2	0.46 ± 0.03

Appendix

Coal regions for conversion, Alberta Plains

First region: Fox Creek (part)

Rank (ASTM): Subbituminous B
Geology: Scollard Member Paskapoo Formation; latest Cretaceous age
Location: 240 km NW of Edmonton, about Tp 65, R 19, W 5 Mer

Deposits	Number (figure 1)	Remaining Reserves Tonnes x 10^6 Strip	Underground	Note
Giroux	1	110	0	Estimates, especially underground, believed to be much too conservative; numerous dirt partings
Atikkamek	2	100	0	
Meekwap W	3	130	0	
Meekwap E	4	160	23	
S. Brush Mtn.	5	210	24	
Goose River	6	45	0	
Total		755	47	

Mineability: Seams thick; ash content variable; stripping ratios favorable; topography flat to rolling; conventional oil and gas fields can be integrated with mining.

Environmental constraints: low
No agriculture; critical wildlife area limited and clearly segregated; much muskeg; harvesting of productive forest can be integrated with mining.

Socioeconomic constraints: low
Rail line; main highway; local oilfield road network; town of Fox Creek (pop. 2000), an oilfield resupply point; recreation areas clearly segregated.

Typical analyses (Attikamek Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 20.3
Ash (as received)	% - (11.5)
Fixed carbon	% - 48.9
Calorific value	Btu/lb -10,440

Ultimate (elemental; water out)

Sulfur	% - 0.6

Significantly comparable coal, available as bulk samples: Highvale Mine, Wabamun Coal Region, Tp 52, R 4, W 5 Mer (53°29'N; 114°34'W).

Second Region: South Swan Hills

Rank (ASTM): Subbituminous C
Geology: Scollard Member Paskapoo Formation latest Cretaceous age
Location: 160 km W of Edmonton, about Tp 64, R 10, W 5 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground	Note
Freeman Creek	7	10	0	Estimates, especially underground, believed to be much too conservative; much very dirty coal.
Judy Creek	8	230	76	
Carson Lake	9	55	19	
Total		295	95	

Mineability:
Seams thick; ash content variable; stripping ratios favorable in places; topography rolling; conventional oil and gas fields can be integrated with mining.

Environmental constraints: low to medium
No agriculture; critical wildlife area partly segregated; harvesting of productive forest can be integrated with mining.

Socioeconomic constraints: low to medium
No rail line; secondary highway; local oilfield road network; town of Swan Hills (pop. 1500), an oilfield resupply point; recreation areas clearly segregated.

Typical analyses (Freeman Creek Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 25.3
Ash (as received)	% - (16.6)
Fixed carbon	% - 40.9
Calorific value	Btu/lb - 8,690

(Significantly comparable bulk coal sample not immediately available.)

Third region: Mayerthorpe/Wabamun (part)

Rank (ASTM): Subbituminous B
Geology: Scollard Member Paskapoo Formation, latest Cretaceous age
Location: 75 km W of Edmonton, about Tp 54, R 7, W 5 Mer

Deposits	Number (figure 1)	Remaining Reserves Tonnes x 10^6 Strip	Underground	Note
Rochfort Bridge	10	3	12	Estimates, especially underground, believed to be much too conservative.
Jalna	11	31	300	
Evansburg	12	0	280	
Stanger	13	27	0	
Magnolia	14	94	10	
Total		155	602	

Mineability:
Seams medium to thick; ash content variable; stripping ratios favorable in places; topography flat.

Environmental constraints: low
Little agriculture; critical wildlife areas limited and clearly segregated; much muskeg; little productive forest.

Socioeconomic constraints: low
Main rail line; main highways; some local roads; established villages (Mayerthorpe, Evansburg, Entwistle, Wildwood); recreation areas limited and clearly segregated.

Typical analyses (Magnolia Deposit)
Proximate (Capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 21.8
Ash (as received)	% - (10.3)
Fixed carbon	% - 49.3
Calorific value	Btu/lb - 10,230

Ultimate (elemental; Water out)

Carbon	% - 77.6
Hydrogen	% - 4.7
Nitrogen	% - 1.2
Oxygen	% - 16.3
Sulfur	% - 0.6

Significantly comparable coal, available as bulk samples: Highvale Mine, Wabamun Coal Region, Tp 52, R 4, W 5 Mer (53°29'N; 114°34'W).

Fourth region: Wabamun/Wetaskiwin (part)

Rank (ASTM): Subbituminous B
Geology: Scollard Mbr. Paskapoo Fm., latest Cretaceous age
Location: 70 km W of Edmonton, about Tp 52, R 4, W 5 Mer

Deposits	Number (figure 1)	Remaining Reserves Tonnes x 10^6 Strip	Underground	Note
Gainford	15	120	39	The major coal producing region of Alberta Plains; 4 major strip mines and 4 mine-mouth thermoelectric plants in operation or in developmental stages; estimates, especially underground, believed to be too conservative.
Whitewood	16	96	25	
Sundance	17	290	26	
Highvale-Low Water	18	74	86	
Keephills	19	110	80	
Genesee	20	370	120	
Total		1060	376	

Mineability:
Seams thick; ash content variable; stripping ratios favorable; topography rolling.

Environmental constraints: low
Poor to fair agriculture; critical wildlife areas limited and clearly segregated; no productive forest.

Socioeconomic constraints: medium
Main rail line; main highways; fair local road network; established villages (Wabamun, Seba Beach); prime recreational area is carefully segregated.

Typical analyses (Whitewood Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% -23.5
Ash (as received)	% - (8.0)
Fixed carbon	% - 46.4
Calorific value	Btu/lb - 9,780

Ultimate (elemental; water out)

Carbon	% - 75.9
Hydrogen	% - 4.6
Nitrogen	% - 1.0
Oxygen	% - 18.3
Sulfur	% - 1.1

Representative coal, available as bulk samples: Highvale Mine, Tp 52, R 4, W 5 Mer (53°29'N; 114°34'W).

Fifth region: Wetaskiwin (part)

Rank (ASTM): Subbituminous B
Geology: Scollard Member Paskapoo Formation, latest Cretaceous age
Location: 50 km SW of Edmonton, about Tp 46, R 26, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserves Tonnes x 10^6 Strip	Underground	Note
Thorsby	21	94	29	
Wizard Lake	22	100	38	
Patience	23	210	0	
Falun	24	0	200	
Bearhills	25	0	62	
Total		404	329	

Mineability:
Seams thick, glacially deformed; ash content variable; stripping ratios mostly favorable; topography flat.

Environmental constraints: severe
Prime agricultural region.

Socioeconomic constraints: medium
Main rail line; main highways; good local road network; several large towns and cities; prime recreational area would have to be carefully segregated.

Typical analyses (Wizard Lake Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 21.8
Ash (as received)	% - (7.6)
Fixed carbon	% - 48.5
Calorific value	Btu/lb - 10,390

Ultimate (elemental; water out)

Carbon	% - 77.9
Hydrogen	% - 5.0
Nitrogen	% - 1.2
Oxygen	% - 15.7
Sulfur	% - 0.3

Ash-fusion data (degrees Celsius)

Softening Temperature Low	High	Softening Interval	Flowing Interval
1110	1326	50	56

Significantly comparable coal, available as bulk samples:
Highvale Mine, Wabamun Coal Region, Tp 52, R 4, W 5 Mer (53°29'N; 114°34'W).

Sixth Region: Red Deer (part)

Rank (ASTM): Subbituminous B
Geology: Scollard Member Paskapoo Formation, latest Cretaceous age
Location: 135 km S of Edmonton, 145 km NE of Calgary, about Tp 39, R 23, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground	Note
Tees, Heatburg, Haynes	26	246	95	Underground estimates believed to be too conservative; numerous dirt partings in lower part of seam.
North Ardley	27	310	170	
Goosequill, Rumsey, Elnora	28	7	0	
South Ardley	29	49	27	
Trochu	30	32	48	
Total		644	340	

Mineability:
Seams medium to thick; ash content variable; stripping ratios marginal; topography flat to rolling.

Environmental constraints: medium to severe
Fair-to-prime agricultural land; river canyon has critical wildlife areas and picturesque, high, unstable or very unstable walls.

Socioeconomic constraints: low
Main rail line; highways; good local road network; several large towns and cities nearby; recreation areas clearly segregated.

Typical analyses (North Ardley Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 21.8
Ash (as received)	% - (8.2)
Fixed carbon	% - 48.4
Calorific value	Btu/lb - 10,180

Ultimate (elemental; water out)

Carbon	% - 77.7
Hydrogen	% - 5.0
Nitrogen	% - 1.3
Oxygen	% - 15.6
Sulfur	% - 0.4

Volume-weight relation (solid coal as in seam)
Percentage of ash - 8
Specific gravity - 1.34

Ash-fusion data (degrees Celsius)

Softening Temperature Low	High	Softening Interval	Flowing Interval
1110	1321	44	67

Representative coal, available as bulk samples; Sissons' Mine, Tp 39, R 23 W 4 Mer (52°18′N; 113°14′W).

Seventh Region: Barrhead/Morinville (part)

Rank (ASTM): Subbituminous C
Geology: Horseshoe Canyon Formation, late Cretaceous age
Location: 40 km N of Edmonton, about Tp 57, R 26, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground	Note
Bloomsbury	31	65	0	Estimates, especially underground, believed to be too conservative.
Manola	32	25	9	
Pickardville, George Lake	33	215	24	
Manawan Lake	34	220	0	
Total		525	33	

Mineability:
Seams moderately thick; ash content low; stripping ratios favorable; topography flat; roof conditions favorable.

Environmental constraints: medium
Good to prime agricultural land.

Socioeconomic constraints: low
Rail lines; highways; good local road network; towns and cities; recreation areas clearly segregated.

Typical analyses (Picardville Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 29.3
Ash (as received)	% - (6.8)
Fixed carbon	% - 41.2
Calorific value	Btu/lb - 9,110

Ultimate (elemental; water out)

Carbon	% - 75.5
Hydrogen	% - 4.7
Nitrogen	% - 1.4
Oxygen	% - 18.3
Sulfur	% - 0.5

Representative coal, available as bulk samples: Egg Lake Mine, Tp 57, R 26, W 4 Mer (53°53'N; 113°44'W).

Eighth Region: Tofield-Dodds/Battle River (part)

Rank (ASTM): Subbituminous C
Geology: Horseshoe Canyon Formation, late Cretaceous age
Location: 85 km SE of Edmonton, about Tp 46, R 18, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserves Tonnes x 10^6 Strip	Underground	Note
Tofield, Miquelon	35	33	140	Estimates, especially underground, believed to be much too conservative.
Dusty Lake	36	390	0	
Dinant	37	6	530	
Ohaton	38	140	11	
Driedmeat Lake	39	100	170	
Meeting Creek	40	45	84	
Heisler	41	73	0	
Total		787	935	

Mineability:
Seams moderately thick; ash content low; stripping ratios favorable; topography mostly flat; roof conditions favorable.

Environmental constraints: severe
Prime agricultural land; water deficit.

Socioeconomic constraints: low
Rail lines; highways; good local road network; towns and cities; recreation areas limited and clearly segregated.

Typical analyses (Dinant Deposit)

Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 28.0
Ash (as received)	% - (5.2)
Fixed carbon	% - 41.9
Calorific value	Btu/lb - 9,210

Ultimate (elemental; water out)

Carbon	% - 75.2
Hydrogen	% - 5.0
Nitrogen	% - 1.5
Oxygen	% - 17.7
Sulfur	% - 0.6

Volume-weight relations (solid coal as in seam)

Percentage of ash	5 - 10
Specific gravity	1.30 - 1.33

Ash-fusion data (degrees Celsius)

Softening Temperature		Softening Interval	Flowing Interval
Low	High		
1082	1304	50	39

Significantly comparable coal, available as bulk samples:
Vesta Mine, Battle River Region, Tp 40, R 15, W 4 Mer (52°27'N; 112°10'W).

Ninth Region: Battle River (central part)

Rank (ASTM): Subbituminous C
Geology: Horseshoe Canyon Formation, late Cretaceous age
Location: 170 km SE of Edmonton, about Tp 40, R 16, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground	Note
Donalda	42	7	27	A major coal-producing region with three major strip mines and one thermoelectric power plant; estimates, especially underground, believed to be too conservative.
Forestburg	43	23	0	
Central Battle River	44	87	0	
Paintearth	45	39	0	
Gadsby	46	81	9	
Total		240	36	

Mineability:
Seams moderately thick; ash content low; stripping ratios favorable; topography flat; roof conditions favorable.

Environmental constraints: medium
Fair to good agricultural land; critical wildlife areas limited and clearly segregated; water deficit.

Socioeconomic constraints: low
Rail lines; highways; good local road network; established towns (Forestburg, Halkirk); recreational areas limited and clearly segregated.

Typical analyses (Central Battle R. Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 28.4
Ash (as received)	% - (6.3)
Fixed carbon	% - 41.1
Calorific value	Btu/lb - 9,180

Ultimate (elemental; water out)

Carbon	% - 75.4
Hydrogen	% - 5.1
Nitrogen	% - 1.4
Oxygen	% - 18.6
Sulfur	% - 0.6

Representative coal, available as bulk samples: Vesta Mine, Tp 40, R 15, W 4 Mer (52°27′N; 112°10′W).

Tenth Region: Battle River (south part)

Rank (ASTM): Subbituminous C
Geology: Horseshoe Canyon Formation, late Cretaceous age
Location: 175 km SE of Edmonton, 180 km NE of Calgary, about Tp 38, R 15, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground
Halkirk	47	42	0
Castor	48	82	0
Sullivan Lake	49	190	110
Total		314	110

Mineability:
Seams medium to thick; ash content mostly low; stripping ratios favorable; topography flat; roof conditions favorable.

Environmental constraints: medium
Fair to good agricultural land; critical wildlife areas limited and clearly segregated; water deficit.

Socioeconomic constraints: low
Rail lines; highways; good local road network; established towns; recreational areas limited and clearly segregated.

Typical analyses (Castor Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 31.7
Ash (as received)	% - (6.2)
Fixed carbon	% - 38.3
Calorific value	Btu/lb - 8,560

Ultimate (elemental; water out)

Carbon	% - 78.9
Hydrogen	% - 5.1
Nitrogen	% - 1.4
Oxygen	% - 19.1
Sulfur	% - 0.6

Significantly comparable coal; available as bulk samples: Vesta Mine, Battle River Region, Tp 40, R 15, W 4 Mer (52°27'N; 112°10'W).

Eleventh region: Sheerness

Rank (ASTM): Subbituminous C
Geology: Horseshoe Canyon Formation, late Cretaceous age
Location: 165 km ENE of Calgary, about Tp 29, R 13, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground	Note
Sheerness	50	140	0	Major strip mine and mine-mouth thermoelectric power plant under construction; no underground extension.

Mineability:
Seams thick; ash content low; stripping ratio very favorable; topography flat.

Environmental constraints: low to medium
Poor to fair agricultural land; severe water deficit.

Socioeconomic constraints: low
Rail lines; highways; good local road network; established towns and villages (Hanna, Sheerness).

Typical analyses

Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 29.4
Ash (as received)	% - (5.9)
Fixed carbon	% - 40.4
Calorific value	Btu/lb -8,750

Ultimate (elemental; water out)

Carbon	% - 74.2
Hydrogen	% - 4.8
Nitrogen	% - 1.4
Oxygen	% - 19.8
Sulfur	% - 0.6

Representative coal, available as bulk samples: Sheerness Mine, Tp 29, R 13, W 4 Mer (51°28′N; 111°42′W).

Twelfth Region: Drumheller (part)

Rank (ASTM): Subbituminous B (some Subbituminous A)
Geology: Horseshoe Canyon Fm., late Cretaceous age
Location: 105 km NE of Calgary, about Tp 28, R 19, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^9 Strip	Underground	Note
Munson, Kneehill	51	0	280	Underground estimates believed to be too conservation by one order of magnitude.
Rosedale, Eladesor	52	3	138	
East Coulee, Western Monarch	53	0	43	
Total		3	461	

Mineability:
Seams thick, nearly flat-lying; ash content low; no strippable deposits; deep coulees allow level entry; roof conditions favorable.

Environmental constraints: low
Cover (300-500 feet) need not be disturbed.

Socioeconomic constraints: low
Main rail line; highways; good local road network; established mining city (Drumheller); recreation areas can be clearly segregated.

Typical analyses (Rosedale Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 21.6
Ash (as received)	% - (5.0)
Fixed carbon	% - 47.3
Calorific value	Btu/lb - 10,410

Ultimate (elemental; water out)

Carbon	% - 77.0
Hydrogen	% - 5.0
Nitrogen	% - 1.5
Oxygen	% - 16.0
Sulfur	% - 0.6

Volume-weight relation (solid coal as in seam)

Percentage of ash	5-10-15
Specific gravity	1.32-1.36-1.40

Ash-fusion data (degrees Celsius)

Softening Temperature Low	High	Softening Interval	Flowing Interval
1010	1298	33	61

Representative coal, available as bulk samples:
Atlas Mine, Tp 27, R 18, W 4 Mer (51°17'N; 112°31'W).

Thirteenth Region: Blackfoot

Rank (ASTM): Subbituminous B
Geology: Horseshoe Canyon Formation, late Cretaceous age
Location: 100 km ESE of Calgary, about Tp 21, R 20, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^3 Strip	Underground	Note
Blackfoot	54	100	22	Underground estimates believed to be conservative; seams continuous westward to Buffalo Hill Region.

Mineability:
Seams thick; ash content moderate; stripping ratio favorable within bounds of Bow River Valley; topography in valley rolling.

Environmental constraints: medium
Good agricultural land.

Socioeconomic constraints: low
Main rail line; main highway; some local roads; established towns (Bassano, Cluny, Gleichen); Indian lands.

Typical analyses
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 20.0
Ash (as received)	% - (10.5)
Fixed carbon	% - 47.4
Calorific value	Btu/lb - 10,240

(Significantly comparable bulk coal sample not immediately available.)

Fourteenth Region: Buffalo Hills

Rank (ASTM): Subbituminous A (probably)
Geology: Horseshoe Canynon Formation, late Cretaceous age
Location: 85 km SE of Calgary, about Tp 18, R 23, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground	Note
Buffalo Hill	55	0	440	New Region, entirely very deep underground; enormous reserves and high rank reported, but yet to be substantiated.

Mineability:
Entirely underground with vertical hoisting shafts required; deeper (more than 400 m) than any mine ever in Alberta Plains.

Environmental constraints: low
Cover need not be disturbed.

Socioeconomic constraints: low
Rail line, highway; good local road network; established town (Vulcan).

(Analyses confidential; not available; coal reported to be Subbituminous A in rank.)

(Significantly comparable bulk coal sample not immediately available.)

Fifteenth Region: Brooks/East Brooks (part)

Rank (ASTM): Subbituminous B
Geology: Oldman Formation, late Cretaceous age
Location: 250 km SE of Calgary, about Tp 17, R 15, W 4 Mer

Deposits	Number (figure 1)	Remaining Reserve Tonnes x 10^6 Strip	Underground	Note
Bow City - Kitsim	56	67	38	Two 'Fields' (ERCB) necessary for one viable operation.
East Brooks	57	76	0	
Total		140	40	

Mineability:
Medium-thin seams; medium-large stripping ratios; topography flat.

Environmental constraints: medium
Some irrigation agriculture; some critical wildlife areas (antelope).

Socioeconomic constraints: low
Main rail line; main highway; good local road network; established town (Brooks).

Typical analyses (Bow City - Kitsim Deposit)
Proximate (capacity moisture, mineral-matter-free basis)

Capacity moisture	% - 20.0
Ash (as received)	% - (11.9)
Fixed carbon	% - 45.6
Calorific value	Btu/lb - 10,680

Ultimate (elemental; water out)

Carbon	% - 78.6
Hydrogen	% - 5.5
Nitrogen	% - 1.7
Oxygen	% - 15.0
Sulfur	% - 1.0

(Significantly comparable bulk coal sample not immediately available.)

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